

Application No.: 10/524,455
Filing Date: February 10, 2005
Page: 5

REMARKS

Claims 1 through 9 and 11 and new Claim 12 are pending in the application.

Claim 1 has been amended to recite "reversibly" in lieu of "temporarily." Support for this amendment can be found in the Application as-filed, for example on Page 3, lines 18 through 20.

Claim 12 has been added to complete the record for examination and highlight advantageous embodiments of the invention.

Claim 12 is directed to advantageous methods in which the chemical compounds containing at least one aldehyde group and at least one acid group are not released upon dissolving the reversibly crosslinked cellulose ether in a neutral or weakly acidic aqueous solution. Support for Claim 12 can be found in the Application-as-filed, for example on Page 2, line 27 through Page 3, line 21 and on Page 7, lines 24 through 26.

Reexamination and reconsideration of this application, withdrawal of all rejections, and formal notification of the allowability of the pending claims are earnestly solicited in light of the remarks which follow.

Section 112 Rejection

Claim 1 stands rejected as indefinite over the recitation "temporarily." Claim 1 has been amended to recite "reversibly" in lieu of the foregoing "temporarily," as kindly suggested by the Examiner. As noted above, support for this amendment can be found in the Application-as-filed. Applicants respectfully request withdrawal of the foregoing rejection.

Application No.: 10/524,455
Filing Date: February 10, 2005
Page: 6

Claim 1 stands further rejected over the term "solvation delay." Applicant respectfully submits that "solvation delay" or "open-time" is a term that is well understood to one skilled in the art that refers to a period of time within which a cellulose ether solution or dispersion exhibits a relatively low viscosity. After this period of time, the solution or dispersion viscosity increases dramatically, as further well known to those skilled in the art.

In contrast to the urgings of the Office Action, the Specification clearly defines "solvation delay", including providing an exemplary time range of a few seconds up to a plurality of hours. In this regard, the Examiner's attention is kindly directed to the Application-as-filed on Page 2, lines 13 through 17 (discussing solvation delay generally and providing a general time range) as well as on Page 6, line 29 through Page 7, line 11 (providing solvation delay measurement techniques, and further generally defining the delay as the point in time in which the solution or dispersion viscosity exceeds twice its initial value).

In addition to its general description, the Application-as-filed further provides exemplary solvation delays representative of the instant invention. Example 1 discloses a reversibly cross-linked methyl hydroxyethyl cellulose (MHEC) having a solvation delay of 4.5 minutes, as noted in the Application-as-filed on Page 7, line 24. In Example 2, a reversibly cross-linked HEC is disclosed which has a solvation delay of 5 minutes, as noted in the Application-as-filed on Page 8, line 9.

Accordingly, Applicants respectfully submit that the skilled artisan is well informed of the meaning of solvation delay, both from the general knowledge of one skilled in the art, as well as the general definitions and specific examples provided within the Application-as-filed. Accordingly, Applicants respectfully request withdrawal of the foregoing rejection.

Application No.: 10/524,455
Filing Date: February 10, 2005
Page: 7

The Claimed Invention is Patentable in Light of the Art of Record

Claims 1, 3 through 9 and 11 stand rejected over United States Patent No. 3,072,635 to Menkart¹ et al in light of European Patent Application 0 252 649 A2 to Herron et al.

It may be useful to briefly consider the invention before addressing the merits of the rejection.

The production of aqueous solutions of cellulose ethers can be problematic. This applies, in particular, when the cellulose ether is present as fine powder having enlarged surface area. If such a cellulose ether powder comes into contact with water, the individual granules swell and clump together to form relatively large agglomerates, the surface of which is thickened in a gel-like manner. However, depending on the mixing intensity, a certain proportion of completely unwetted cellulose ether is situated in the interior of these agglomerates. Complete dissolution of these agglomerates can take up to 24 hours. Crosslinking of cellulose can be beneficial in the dissolution of cellulose ethers, for example by controlling swelling.

Glyoxal has heretofore been known for use in crosslinking cellulose ethers, as clearly evidenced by Menkart. Carbalddehyde groups on the glyoxal react with the hydroxy groups of the cellulose ether to form hemiacetal bonds. Hemiacetal bonds are pH sensitive, and cleave when the cross-linked cellulose ether is stirred into neutral or weakly acidic water, as discussed in the Application-as-filed on Page 2, lines 26 through 30, and as further correctly noted by the Examiner. Such cleavage is problematic because it reintroduces the glyoxal back into solution. Glyoxal, as well as a number of other low-molecular weight cross-linkers, pose a potential health risk. Glyoxal has in recent years been categorized as a mutagen and sensitizing substance, for example.

¹ Applicants Representative respectfully submits that United States Patent 3,072,635 ("US 635") indicates on its face that Menkart is the primary inventor, rather than Meukart as indicated in the outstanding Office Action. Accordingly, remarks noting Menkart are intended to distinguish US 635.

Application No.: 10/524,455
Filing Date: February 10, 2005
Page: 8

It was thus an object of the present invention to develop a method by which cellulose ethers can be reversibly crosslinked and which succeeds without the use of low molecular weight generating compounds, such as glyoxal, and which further can be used in large-scale industrial production of crosslinked cellulose ethers without requiring complex and costly modifications or additional treatment steps. In addition, such methods should not substantially interfere with the beneficial rheology heretofore provided by cellulose ethers, particularly its ability to build viscosity after an initial solvation period.

Applicants have found that the use of a mixed functionality cross-linker allows the production of cellulose ether solutions which are readily stirrable and provides a defined solvation delay, without producing small molecules in solution. Applicants further discovered that the inventive reacted cellulose ether goes on to provide a detectable viscosity development within the neutral pH range following a solvation delay, which was quite surprising given that the cleaved cross-linker remains bonded to the reacted cellulose. In that regard, the Examiner's attention is kindly directed to the Application-as-filed on Page 6, lines 9 through 14.

Applicants have more particularly determined that reversible cross-linking compounds that further include an acid group produce an ester upon reacting with a hydroxy group on the cellulose ether. This ester group remains intact when the cross-linked product is brought into contact with water, as discussed in the Application-as-filed on Page 4, lines 9 through 14. Accordingly, no cross-linking agent (e.g. no low molecular weight compound) is released when the cross-linked cellulose ether is dissolved in water, thereby avoiding a possible health risk. Altogether unexpectedly, the ester bonded molecule remaining on the reacted cellulose does not interfere with the rheology of the resulting cellulose solution, however. Instead, inventive cellulose solutions are provided which exhibit both a solvation delay and subsequent viscosity build, such as provided by conventional cellulose solutions, but without the release of a small molecule back into solution.

Application No.: 10/524,455
Filing Date: February 10, 2005
Page: 9

Applicants respectfully submit that the foregoing references do not teach or suggest the claimed invention, considered either alone or in combination.

Menkart is merely directed to the conventional use of aldehyde treating agents. (Col. 1, lines 45 – 50). Menkart generally indicates that any of glyoxal, formaldehyde or succinaldehyde may be reacted with cellulose ethers, with glyoxal being preferred. (Col. 1, lines 48 – 50). The glyoxal may be combined with the cellulose ether by means such as spraying or vapor treatment. (Col. 3, lines 49 – 63). Menkart, disclosing a number of aldehydes, is altogether silent as to acidic groups.

Menkart thus does not teach or suggest the claimed invention.

Menkart, solely directed to aldehyde treating agents, more particularly does not teach or suggest the inventive methods for producing crosslinked cellulose ethers in which cellulose ethers having free OH groups are admixed with chemical compounds containing at least one acid group and the acid groups of the chemical compounds are then reacted with the OH groups of the cellulose ethers to form an ester bond.

And Menkart most certainly does not teach or suggest such advantageous methods in which chemical compounds are not released upon said dissolving the reversibly crosslinked cellulose ether in a neutral or weakly acidic aqueous solution, as recited in new Claim 12. As noted above, Menkart's aldehyde treating agents would instead be released upon contacting the crosslinked cellulose ethers with water, as correctly noted by the Examiner. Applicants further respectfully reiterate that such glyoxal (similar to other low-molecular weight cross-linkers) is volatile and is classified as a health risk, as noted in the Application-as-filed on Page 3, lines 18 through 23.

Accordingly, Applicants respectfully submit that the presently claimed method is patentable in light of Menkart, considered either alone or in combination with Herron.

Application No.: 10/524,455
Filing Date: February 10, 2005
Page: 10

Applicants respectfully submit that the claimed invention is likewise patentable in light of Herron.

In contrast to the inventive reversibly cross-linked pulverulent cellulose ethers, Herron discloses a method for purportedly permanently crosslinking cellulose fibers. (Page 3, line 37). In this method intra-fiber crosslinking is achieved, but not an inter-fiber crosslinking. Herron initially notes that formaldehyde crosslinkers cause skin irritation. (Page 3, lines 15 – 16). Herron then goes on to broadly recommend any of a generic list of alternative aldehyde crosslinking agents. (Page 3, lines 44 – 46). Herron ultimately prefers glutaraldehyde, however, as it is said to provide “the most stable crosslink bonds.” (Page 4, lines 29 – 32, also see Page 10, lines 17 – 18 and Page 15, lines 36 – 42). Herron goes on to expressly teach that his crosslinkers form hemiacetal and acetal bonds, with the acetal bonds selected as “the desired bond types” that further provide “stable crosslink bonds.” (Page 4, lines 54 – 56). Herron preferably processes his fibers so as to favor the formation of such acetal bonds. (Page 4, lines 55 – 58).

To ensure low levels of “residual” crosslinking agent Herron washes the aldehyde crosslinked fibers with an alkaline solution, preferably an alkaline solution having a pH greater than 9. (Page 3, lines 35 – 47 and Page 12, lines 21 – 22). In contrast to Applicants’ findings, Herron teaches that an alkaline pH induces decomposition of hemiacetal bonds. (Page 11, lines 54 – 55). Herron cautions against non-alkaline washes, however, to avoid any detrimental affect to his favored acetal bonds. (Page 11, lines 54 – 57).

Herron’s working examples incorporate glutaraldehyde. (Page 15, line 5 – Page 16, line 42). Herron expressly teaches that “unexpectedly good” results were obtained for fibers having between 0.5 and 3.5 mole % crosslinking agent. (Page 4, lines 35 – 39). In fact, Herron expressly teaches use of 0.5 to 3.5 mole % crosslinking agent on multiple occasions. (Page 7, lines 56 – 57). Herron’s Working Example further indicates a total processing time of 65 minutes to obtain suitable cross-linked fibers. (Page 15, lines 14 – 20). The crosslinked fibers are used to produce absorbent pads with improved absorbency characteristics in comparison to

Application No.: 10/524,455
Filing Date: February 10, 2005
Page: 11

pads formed from conventional, uncrosslinked fiber. (Page. 1, lines 35 -- 39 and Page 13, lines 1 - 2).

Herron, directed to permanently crosslinked cellulose, does not teach or suggest the recited cellulose ethers, much less reversibly crosslinked cellulose ethers. Applicants respectfully submit that the recited cellulose ethers have a much smaller number (less than half) of the free hydroxy groups which could take part in a crosslinking reaction (the other hydroxy groups are etherified and hence no longer reactive), thus there would have been no motivation by Herron to have used them.

More specifically, cellulose ethers have a smaller number of free hydroxy groups which can take part in a cross-linking reaction in comparison to cellulose. The cellulose ethers contemplated in the present invention have a molar degree of substitution of about 1.7 to 2.2, which means that from the 3 hydroxy groups present in each anhydroglucose unit on average about 2 are etherified and thus cannot react with cross-linking agents. Furthermore, not all hydroxy groups in the anhydroglucose unit show the same reactivity. More reactive are those in the 2- and 6- position. The hydroxyl group in the 3-position is much less reactive. In a cellulose ether having an average molar degree of substitution of about 2, the hydroxyl groups in the 2- and 6-position are etherified and thus already blocked and only the hydroxyl group in the 3 position is still available. But this hydroxy group is not readily accessible for cross-linking agents.

Thus would have been no motivation to have formed the recited crosslinked cellulose ethers in light of Herron, and most certainly not such crosslinked cellulose ethers including reversible crosslinked bonds.

Nor does Herron, directed to fibers, teach or suggest such cellulose ether having lump-free stirrability and solvation delay, as the foregoing recited terminology is associated with pulverulent products.

Application No.: 10/524,455
Filing Date: February 10, 2005
Page: 12

Herron, focusing on the formation of hemiacetal and acetal bonds and specifically teaching glutaraldehyde, further does not teach or suggest reacting cellulose ether with chemical compounds containing at least one acid group. Herron instead teaches the use of conventional crosslinkers, e.g. glutaraldehyde.

Herron, expressly teaching 0.5 to 3.5 mole % crosslinking agent on multiple occasions, most certainly does not teach or suggest the incorporation of chemical compounds containing at least one aldehyde group and at least one acid group in amounts ranging from 0.01 to 0.1 mol per mole of cellulose ether, as recited in Claim 5. Nor would there have been any motivation to have selected such a range in light of Herron.

Herron, teaching a total reaction time of 65 minutes, also does not teach or suggest admixing over a time period as short as 10 min, as recited in Claim 7. Nor would there have been any motivation to have done so based upon the permanent crosslinking imparted by Herron.

And Herron, expressly teaching alkaline washes, can not teach or suggest advantageous methods in which the chemical compounds containing at least one aldehyde group and at least one acid group are not released upon dissolving the reversibly crosslinked cellulose ether in a neutral or weakly acidic aqueous solution, as recited in new Claim 12. Herron instead teaches that either its acetal or hemiacetal bonds would be cleaved under such conditions, thereby releasing his preferred glutaraldehyde.

Accordingly, Applicants respectfully submit that the claimed invention cannot be rendered obvious in light of Herron, considered either alone or in combination with the remaining art of record.

Application No.: 10/524,455
Filing Date: February 10, 2005
Page: 13

Applicants further respectfully submit that there would have been no motivation to have combined Menkart and Herron. Menkart is directed to the conventional use of glyoxal to promote dispersibility. Herron is directed to permanently crosslinked fibers used in absorbent pads. These are altogether different fields of endeavor and problems solved.

However, even if Applicants had combined Menkart and Herron (which they did not do), the claimed invention would not have resulted.

Particularly, the combination of references does not teach or suggest the inventive methods for producing cross-linked cellulose ethers in which cellulose ethers are admixed with chemical compounds containing at least one aldehyde group and at least one acid group and the acid groups of the chemical compounds are then reacted with the OH groups of the cellulose ethers to form an ester bond.

And the combination most certainly does not teach or suggest that such cellulose ethers including chemical compounds containing at least one aldehyde group and at least one acid group would provide lump-free stirrability and solvation delay on stirring into aqueous solutions, as further recited in the claims.

Nor does the combination teach or suggest such advantageous methods in which chemical compounds are not released upon said dissolving said reversibly crosslinked cellulose ether in a neutral or weakly acidic aqueous solution, as recited in new Claim 12. In fact, both the cited references teach away from the advantageous aspects of Claim 12.

Accordingly, Applicants respectfully submit that the claimed invention is patentable in light Menkart and Herron, considered either alone or in combination.

Application No.: 10/524,455
Filing Date: February 10, 2005
Page: 14

CONCLUSION

It is respectfully submitted that Applicants have made a significant and important contribution to the art, which is neither disclosed nor suggested in the art. It is believed that all of pending Claims 1, 3 through 9, 11 and 12 are now in condition for immediate allowance. It is requested that the Examiner telephone the undersigned if any questions remain to expedite examination of this application.

It is not believed that extensions of time or fees are required, beyond those which may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time and/or fees are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required is hereby authorized to be charged to Deposit Account No. 50-2193.

Respectfully submitted,




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